T092h0" 990hh860

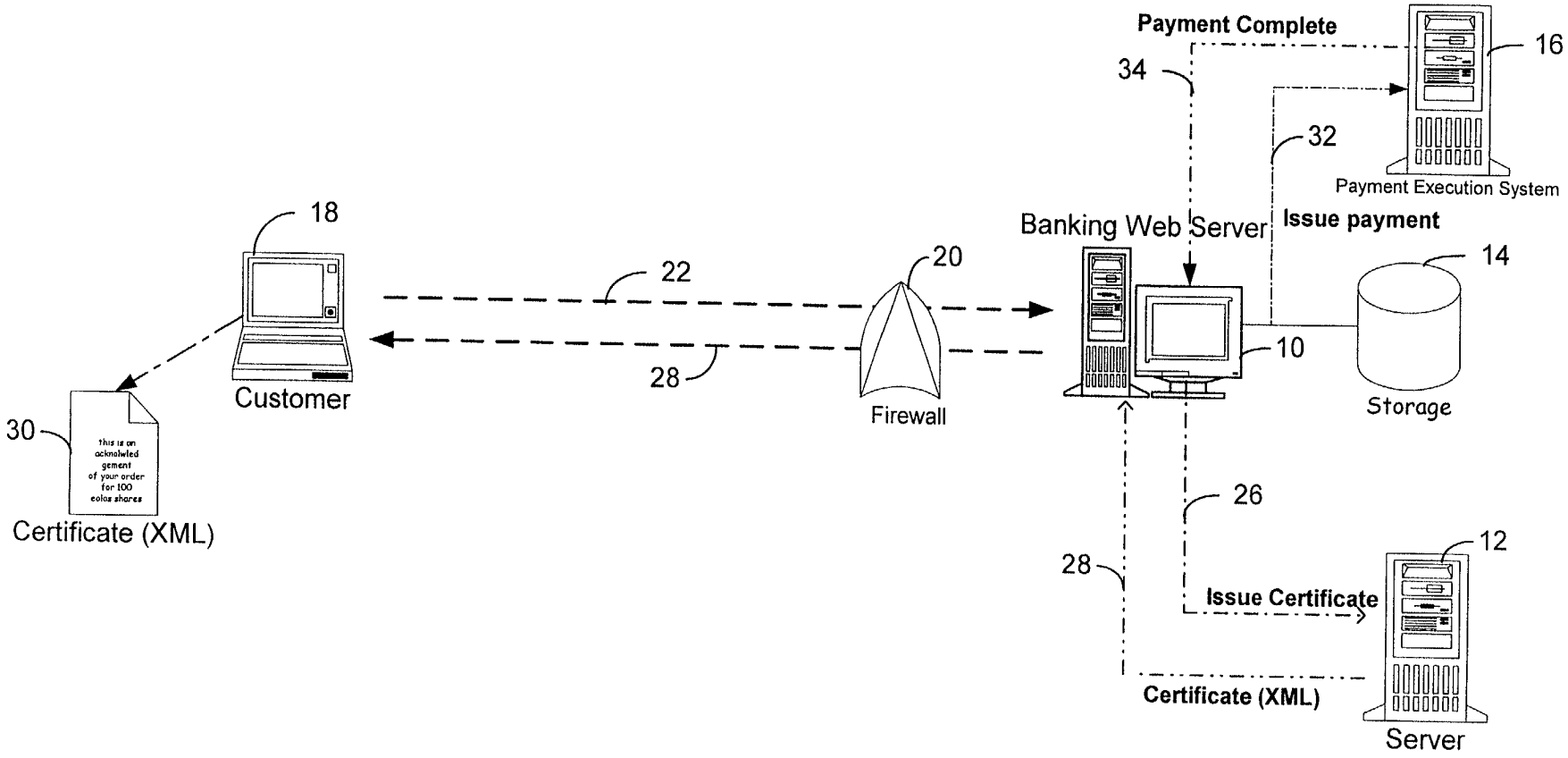


FIG. 1

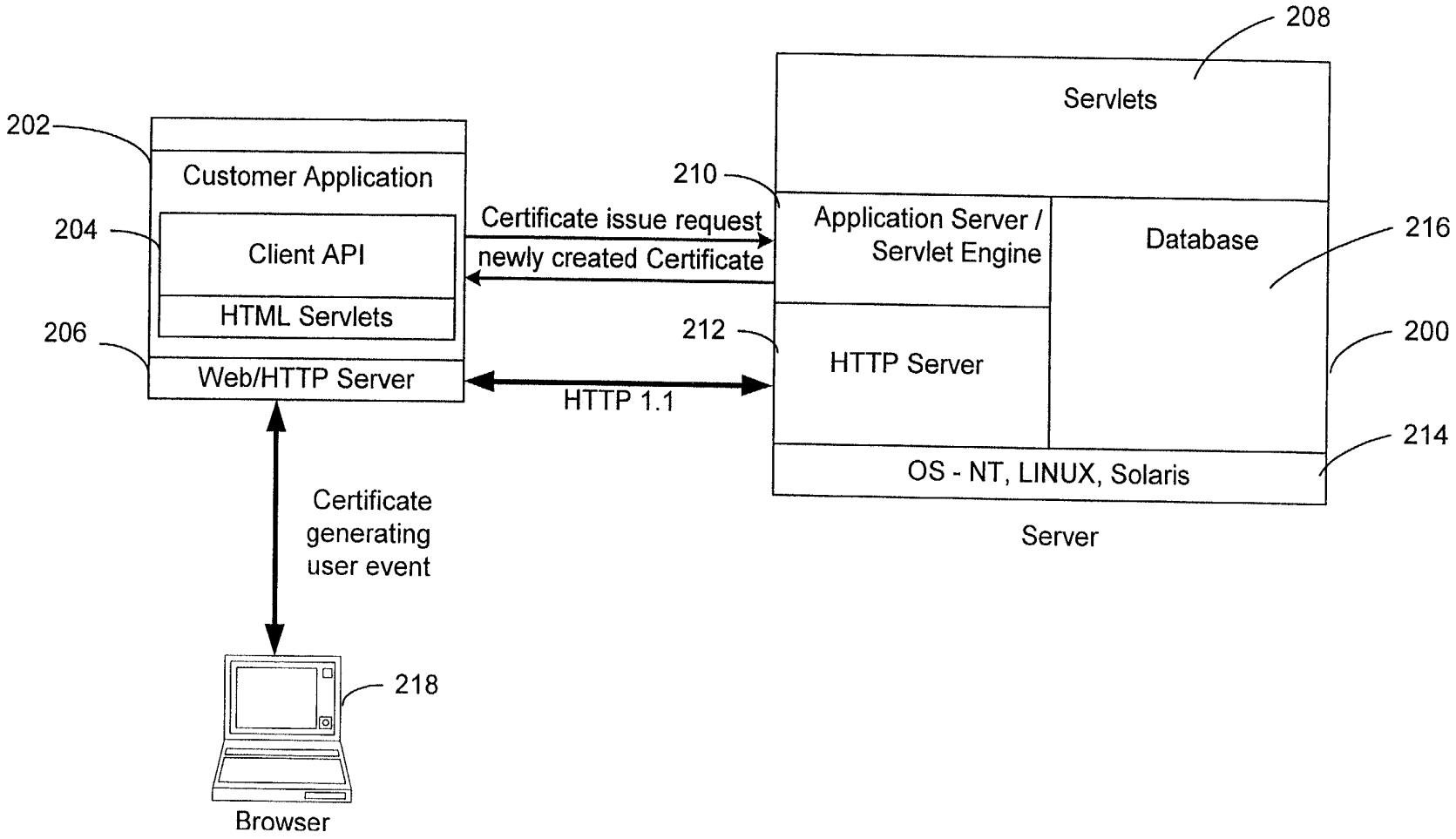
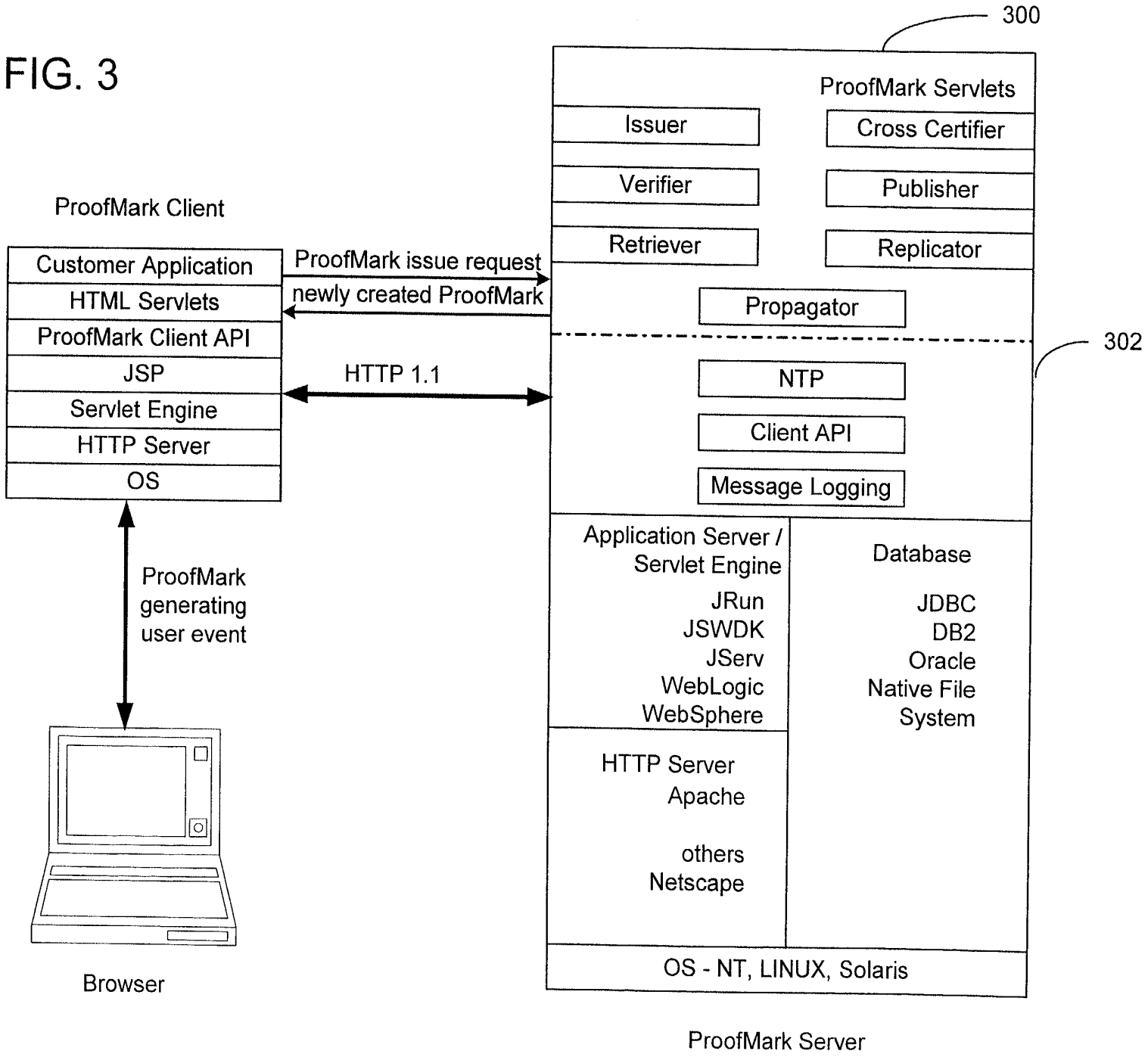

208
Servlets
202
Customer Application
210
204
Client API
Certificate issue request
newly created Certificate
Application Server /
Servlet Engine
Database
216
HTML Servlets
206
212
HTTP Server
200
Web/HTTP Server
HTTP 1.1
214
OS - NT, LINUX, Solaris
Server
Certificate
generating
user event
218
Browser

FIG. 2

TOSHIBA SOLUTIONS

FIG. 3



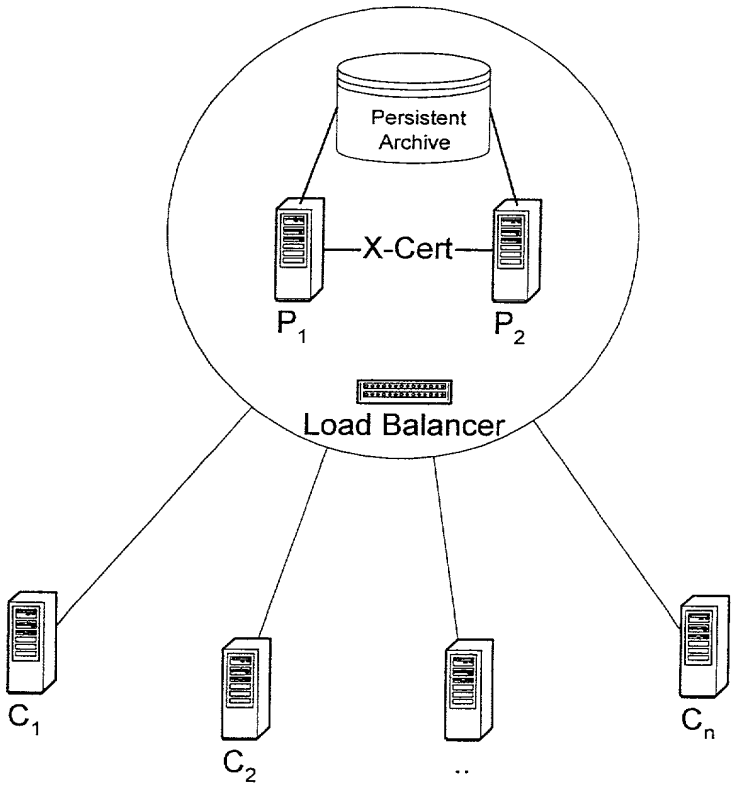


FIG. 4

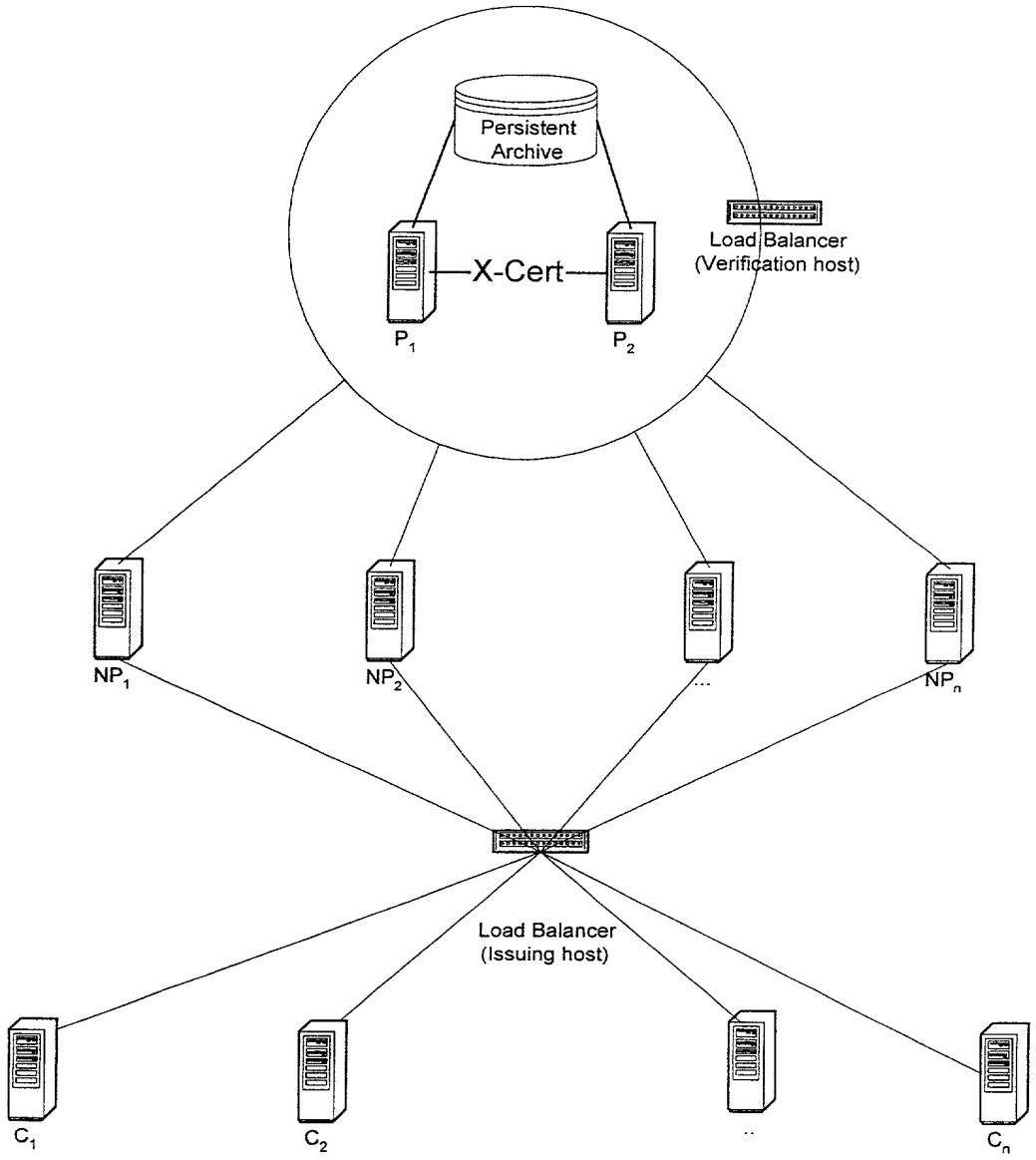

Persistent Archive
X-Cert
P1
P2
Load Balancer (Verification host)
NP1
NP2
...
NPn
Load Balancer (Issuing host)
C1
C2
..
Cn

FIG. 5

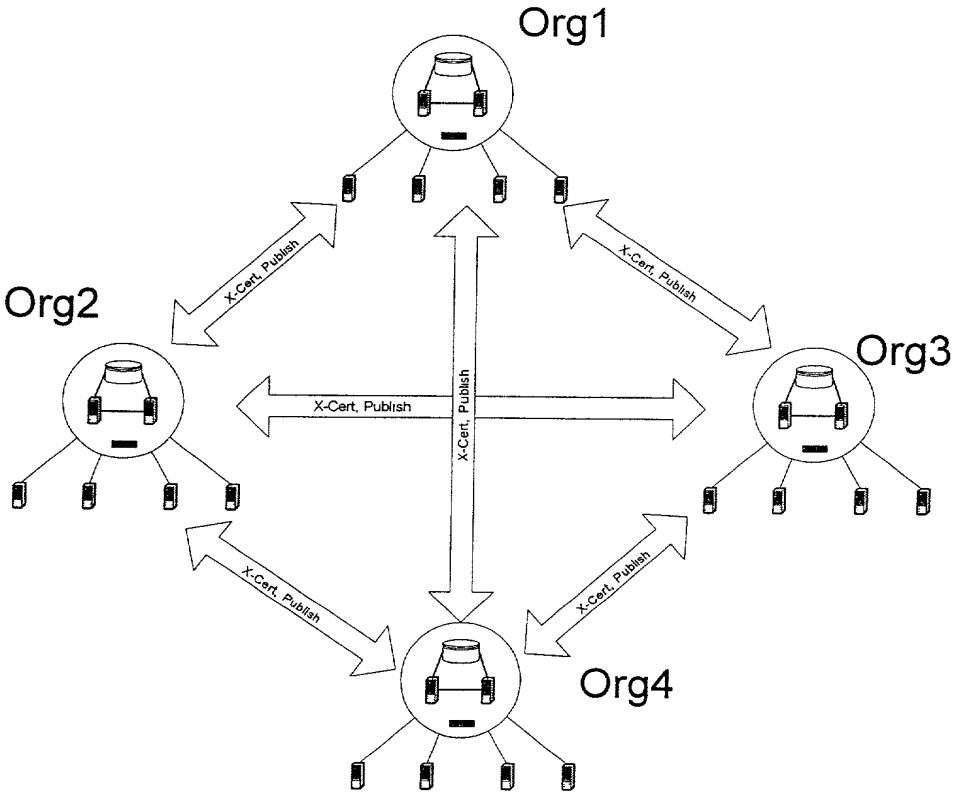

Org1
Org2
Org3
Org4
X-Cert, Publish
X-Cert, Publish
X-Cert, Publish
X-Cert, Publish
X-Cert, Publish
X-Cert, Publish

FIG. 6

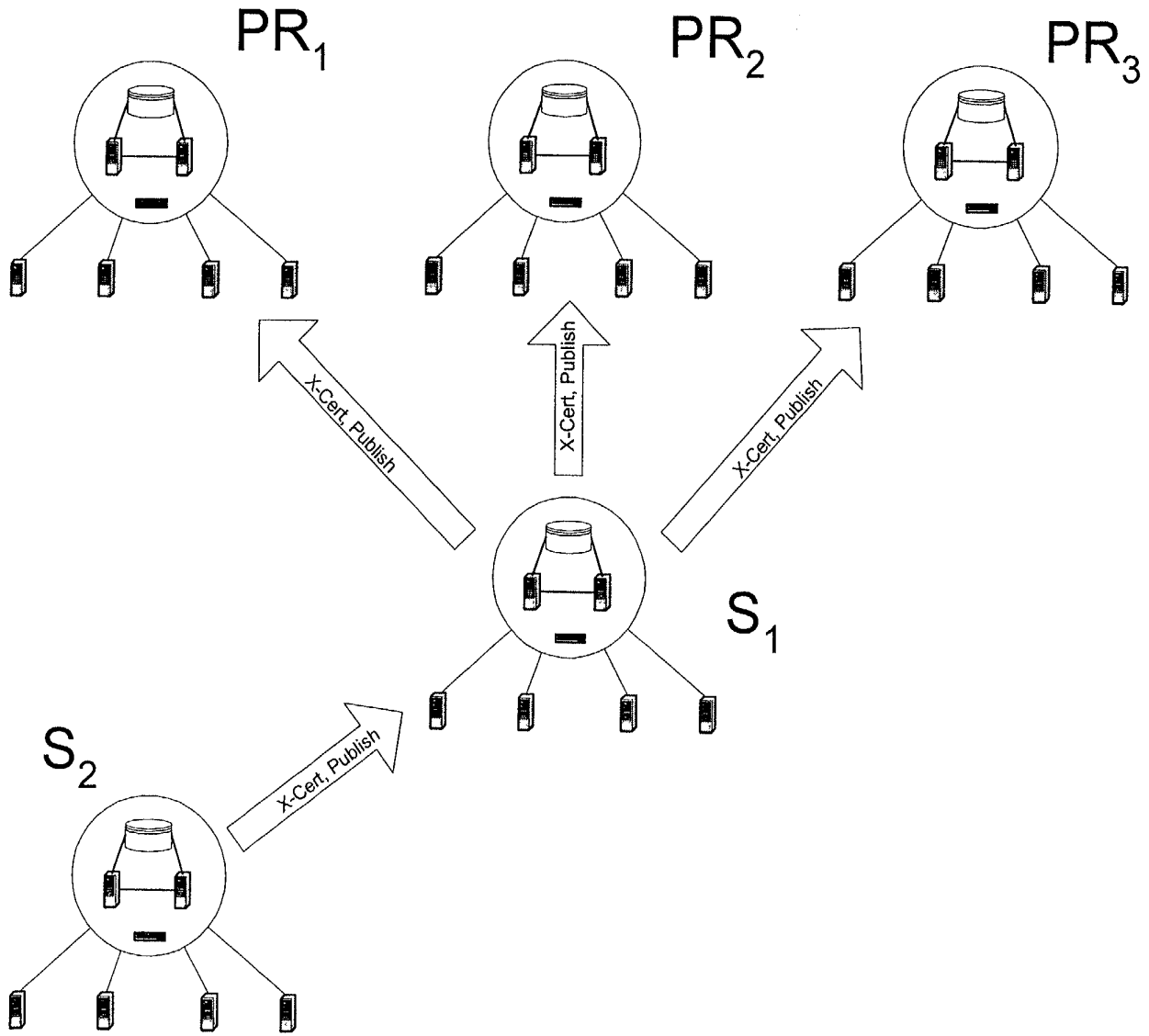

PR1
PR2
PR3
X-Cert, Publish
X-Cert, Publish
X-Cert, Publish
S1
S2
X-Cert, Publish

FIG. 7

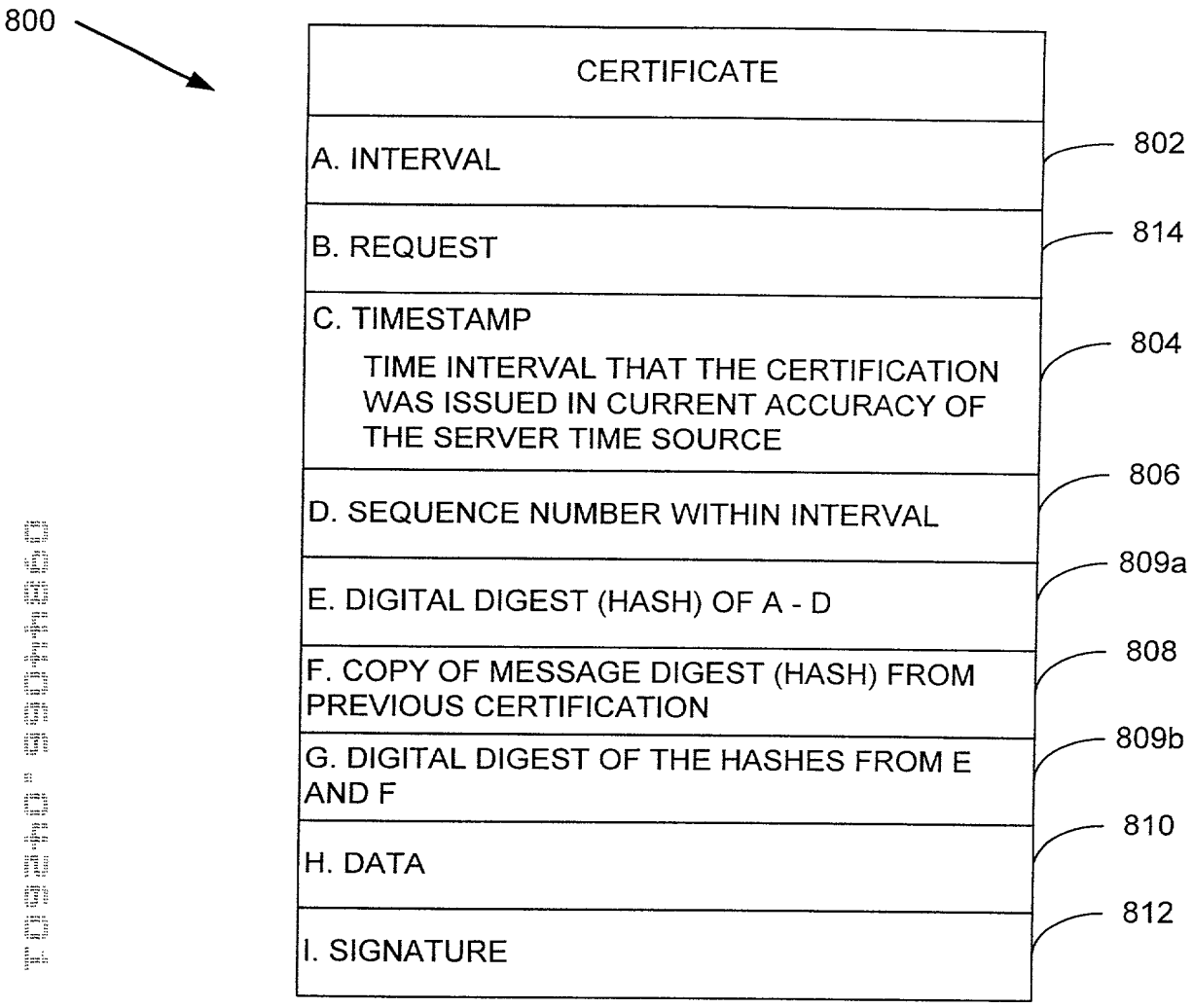

800
CERTIFICATE
A. INTERVAL
B. REQUEST
C. TIMESTAMP
TIME INTERVAL THAT THE CERTIFICATION WAS ISSUED IN CURRENT ACCURACY OF THE SERVER TIME SOURCE
D. SEQUENCE NUMBER WITHIN INTERVAL
E. DIGITAL DIGEST (HASH) OF A - D
F. COPY OF MESSAGE DIGEST (HASH) FROM PREVIOUS CERTIFICATION
G. DIGITAL DIGEST OF THE HASHES FROM E AND F
H. DATA
I. SIGNATURE
802
814
804
806
809a
808
809b
810
812

FIG. 8

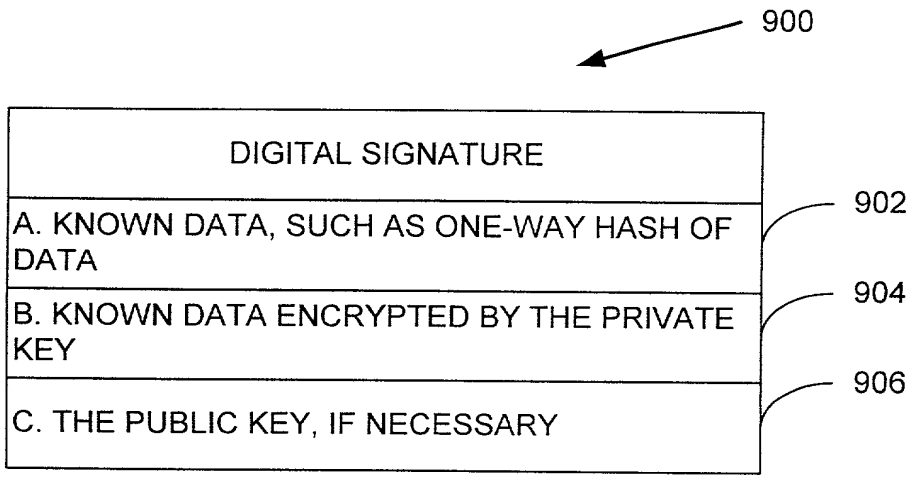

900
DIGITAL SIGNATURE
A. KNOWN DATA, SUCH AS ONE-WAY HASH OF DATA
B. KNOWN DATA ENCRYPTED BY THE PRIVATE KEY
C. THE PUBLIC KEY, IF NECESSARY
902
904
906

FIG. 9

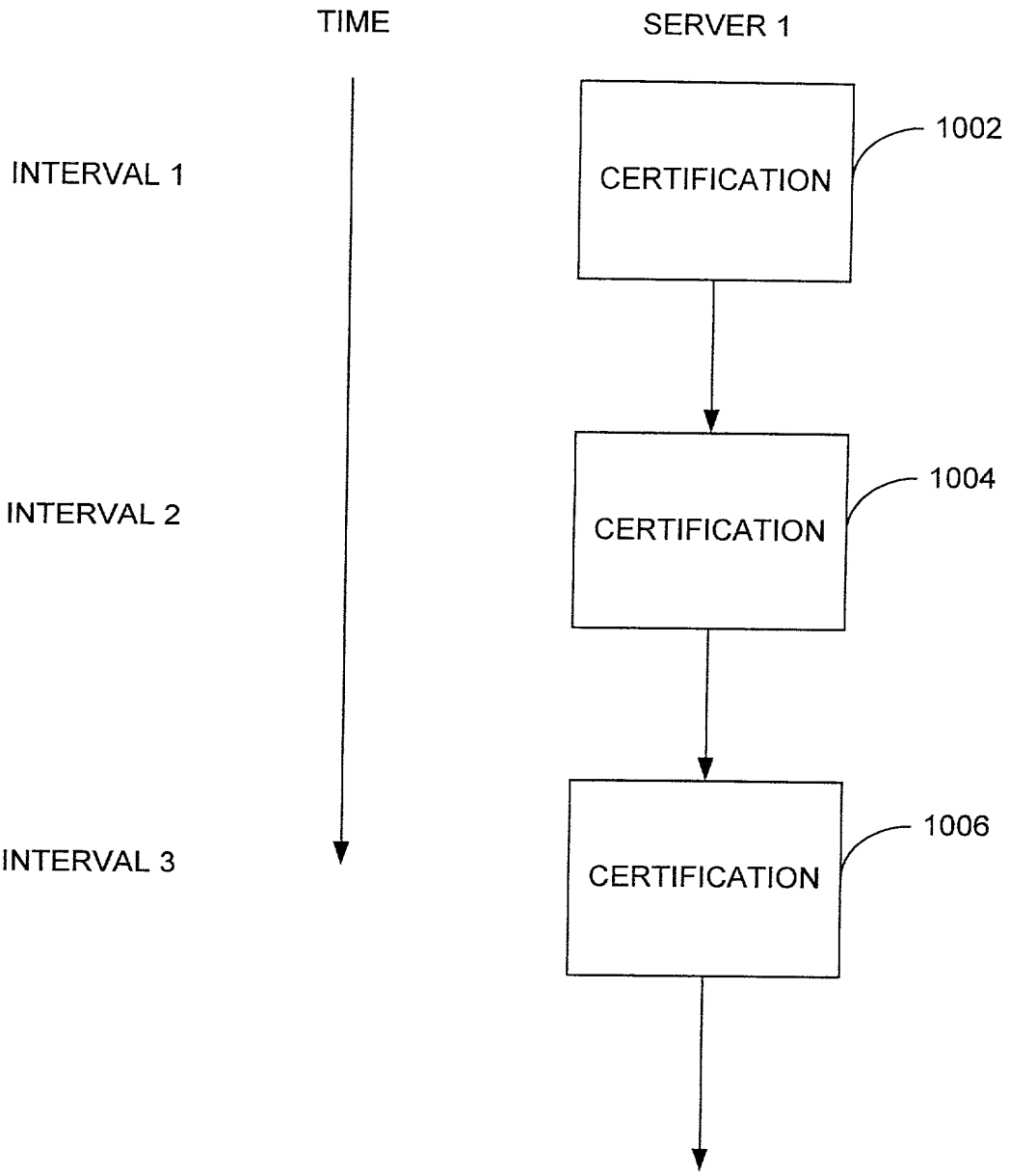

TIME
SERVER 1
INTERVAL 1
INTERVAL 2
INTERVAL 3
CERTIFICATION
CERTIFICATION
CERTIFICATION
1002
1004
1006

FIG. 10

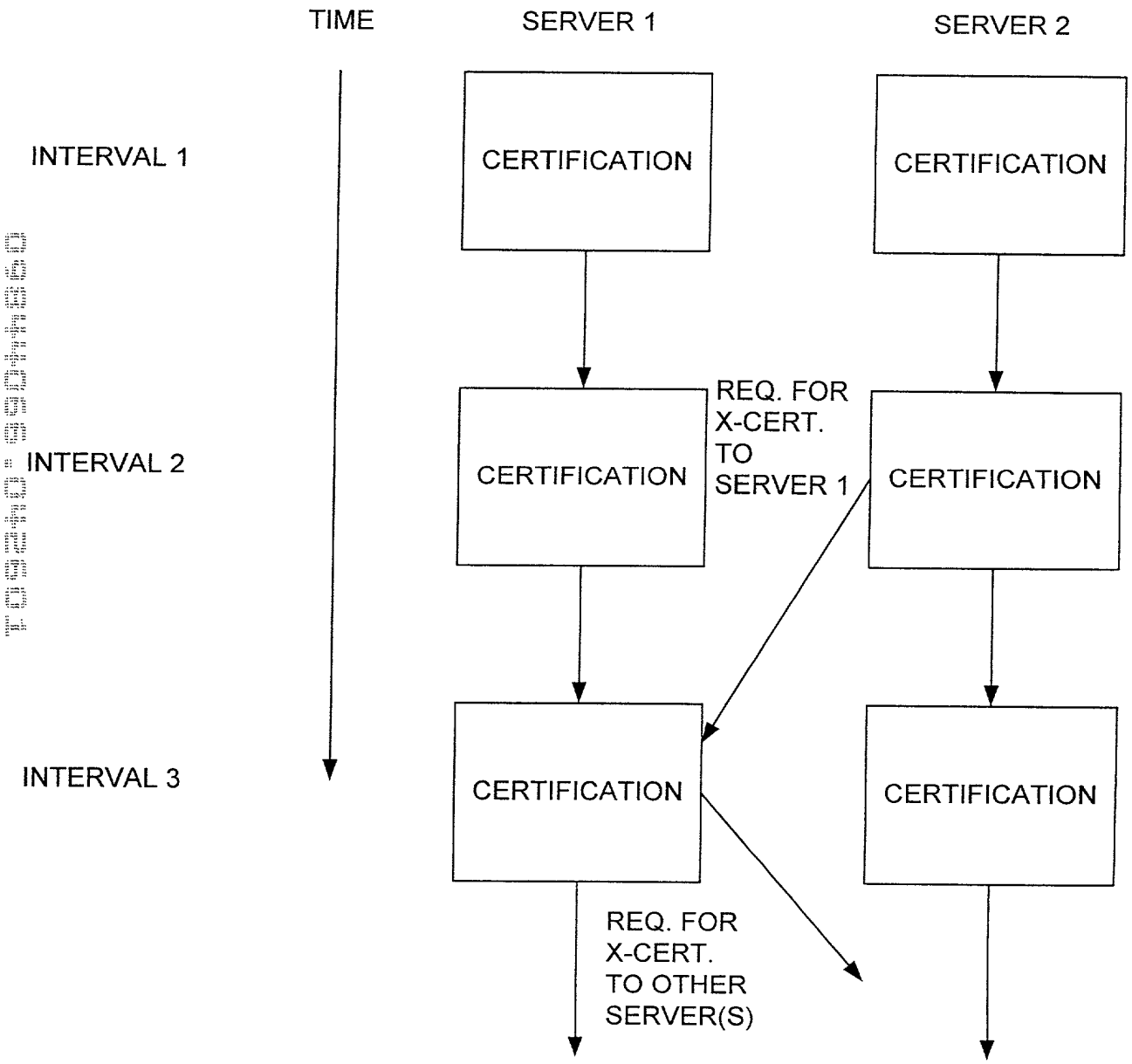

TIME
SERVER 1
SERVER 2
INTERVAL 1
INTERVAL 2
INTERVAL 3
CERTIFICATION
CERTIFICATION
CERTIFICATION
CERTIFICATION
CERTIFICATION
CERTIFICATION
REQ. FOR X-CERT. TO SERVER 1
REQ. FOR X-CERT. TO OTHER SERVER(S)

FIG. 11

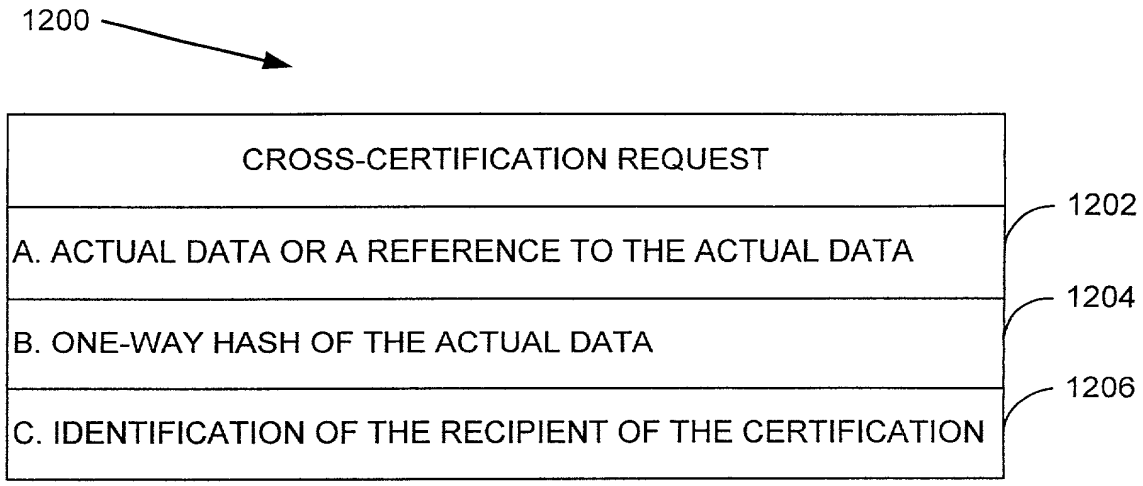

1200
CROSS-CERTIFICATION REQUEST
A. ACTUAL DATA OR A REFERENCE TO THE ACTUAL DATA
B. ONE-WAY HASH OF THE ACTUAL DATA
C. IDENTIFICATION OF THE RECIPIENT OF THE CERTIFICATION
1202
1204
1206

FIG. 12

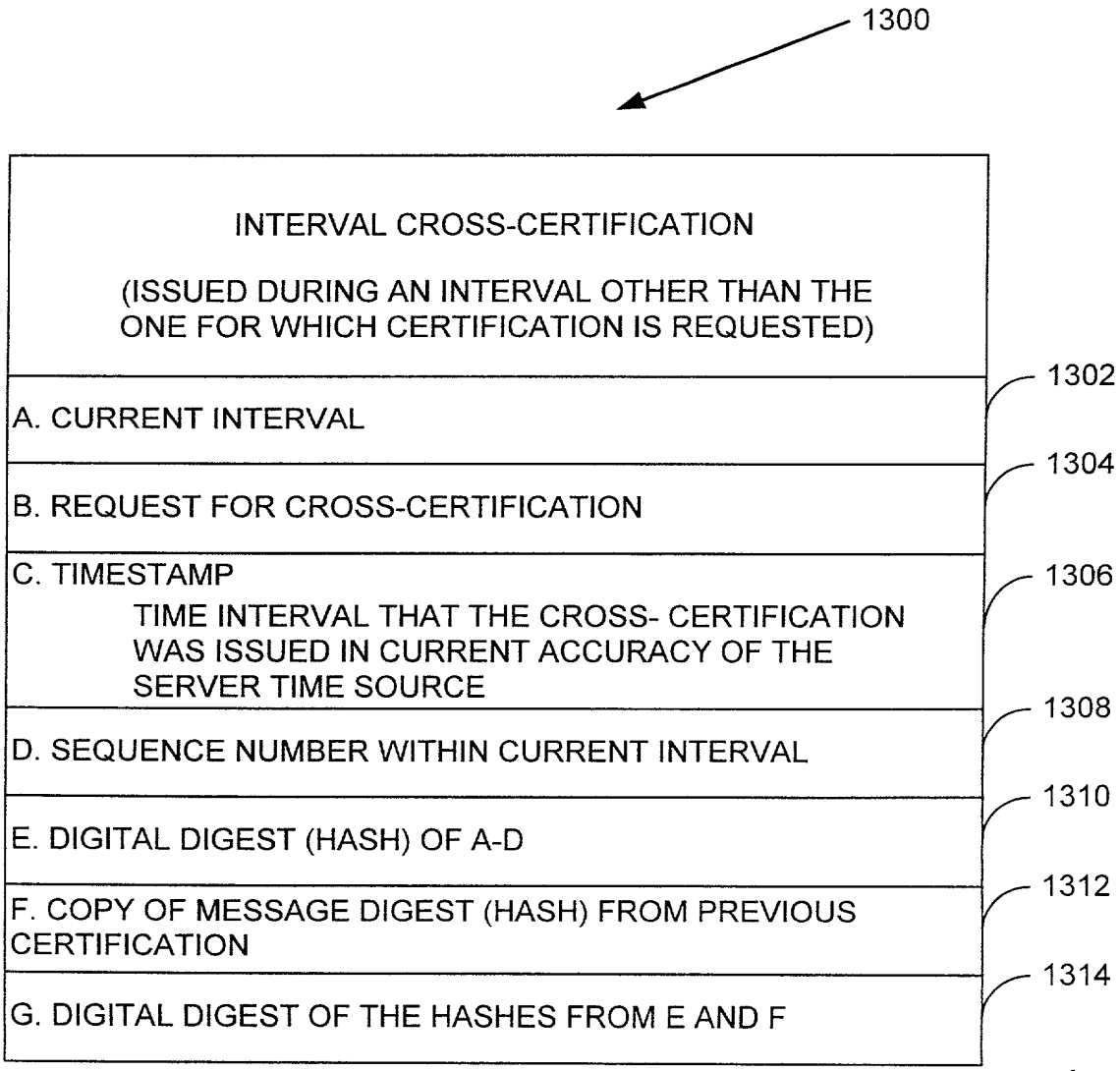

1300
INTERVAL CROSS-CERTIFICATION
(ISSUED DURING AN INTERVAL OTHER THAN THE ONE FOR WHICH CERTIFICATION IS REQUESTED)
A. CURRENT INTERVAL
B. REQUEST FOR CROSS-CERTIFICATION
C. TIMESTAMP
TIME INTERVAL THAT THE CROSS- CERTIFICATION WAS ISSUED IN CURRENT ACCURACY OF THE SERVER TIME SOURCE
D. SEQUENCE NUMBER WITHIN CURRENT INTERVAL
E. DIGITAL DIGEST (HASH) OF A-D
F. COPY OF MESSAGE DIGEST (HASH) FROM PREVIOUS CERTIFICATION
G. DIGITAL DIGEST OF THE HASHES FROM E AND F
1302
1304
1306
1308
1310
1312
1314

FIG. 13

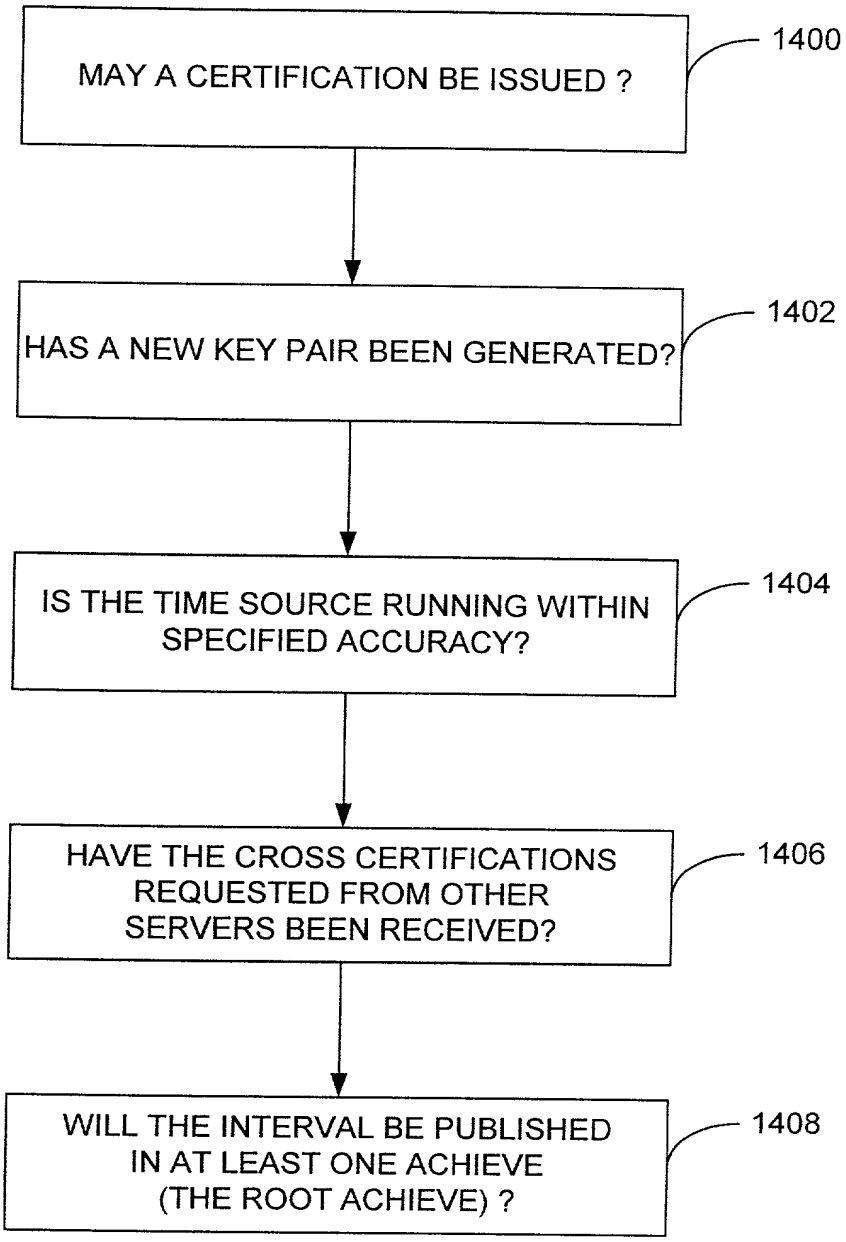

MAY A CERTIFICATION BE ISSUED ?
1400
HAS A NEW KEY PAIR BEEN GENERATED?
1402
IS THE TIME SOURCE RUNNING WITHIN SPECIFIED ACCURACY?
1404
HAVE THE CROSS CERTIFICATIONS REQUESTED FROM OTHER SERVERS BEEN RECEIVED?
1406
WILL THE INTERVAL BE PUBLISHED IN AT LEAST ONE ACHIEVE (THE ROOT ACHIEVE) ?
1408

FIG. 14

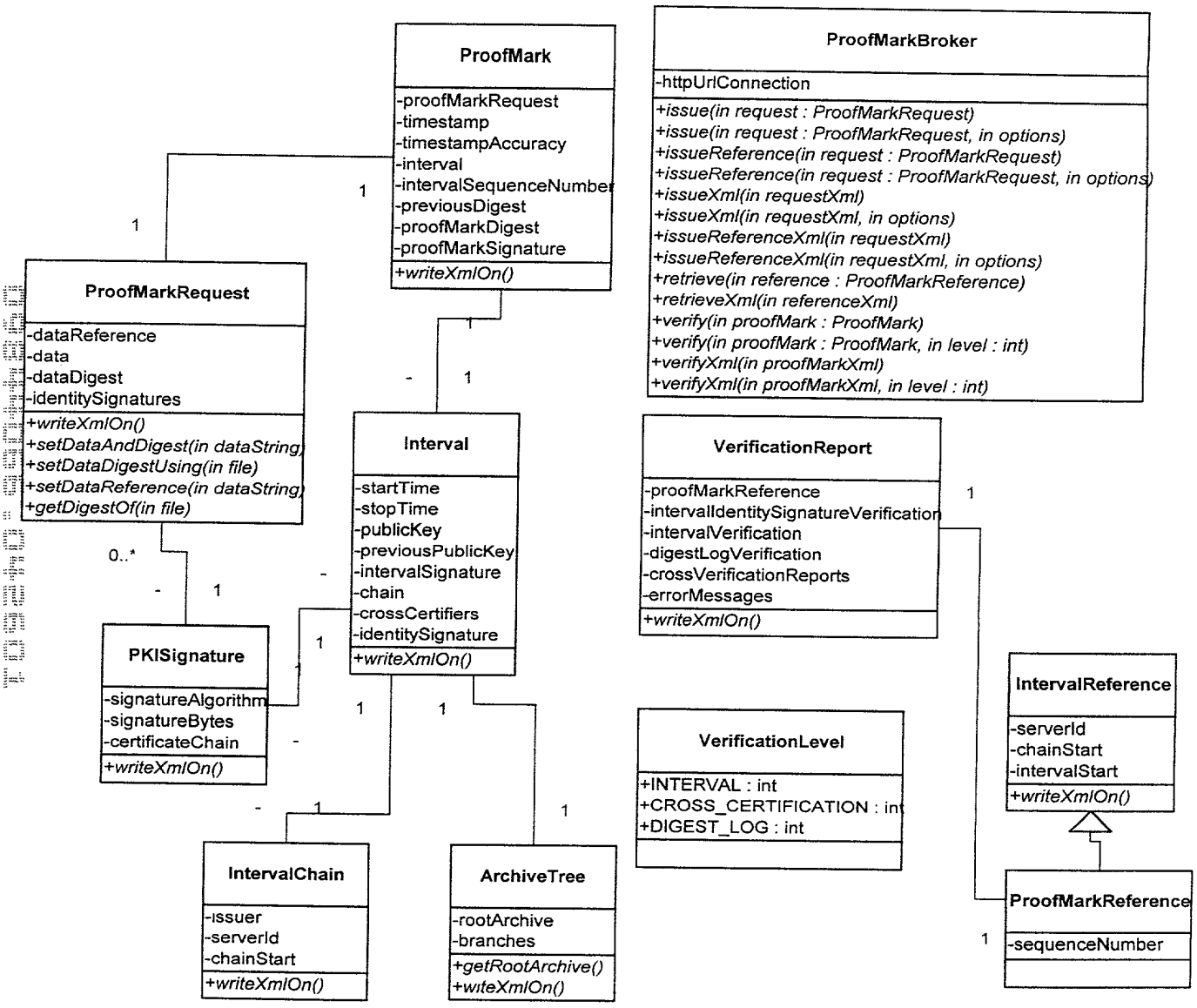

ProofMark
-proofMarkRequest
-timestamp
-timestampAccuracy
-interval
-intervalSequenceNumber
-previousDigest
-proofMarkDigest
-proofMarkSignature
+writeXmlOn()
ProofMarkBroker
-httpUrlConnection
+issue(in request : ProofMarkRequest)
+issue(in request : ProofMarkRequest, in options)
+issueReference(in request : ProofMarkRequest)
+issueReference(in request : ProofMarkRequest, in options)
+issueXml(in requestXml)
+issueXml(in requestXml, in options)
+issueReferenceXml(in requestXml)
+issueReferenceXml(in requestXml, in options)
+retrieve(in reference : ProofMarkReference)
+retrieveXml(in referenceXml)
+verify(in proofMark : ProofMark)
+verify(in proofMark : ProofMark, in level : int)
+verifyXml(in proofMarkXml)
+verifyXml(in proofMarkXml, in level : int)
ProofMarkRequest
-dataReference
-data
-dataDigest
-identitySignatures
+writeXmlOn()
+setDataAndDigest(in dataString)
+setDataDigestUsing(in file)
+setDataReference(in dataString)
+getDigestOf(in file)
Interval
-startTime
-stopTime
-publicKey
-previousPublicKey
-intervalSignature
-chain
-crossCertifiers
-identitySignature
+writeXmlOn()
VerificationReport
-proofMarkReference
-intervalIdentitySignatureVerification
-intervalVerification
-digestLogVerification
-crossVerificationReports
-errorMessages
+writeXmlOn()
PKISignature
-signatureAlgorithm
-signatureBytes
-certificateChain
+writeXmlOn()
VerificationLevel
+INTERVAL : int
+CROSS_CERTIFICATION : int
+DIGEST_LOG : int
IntervalReference
-serverId
-chainStart
-intervalStart
+writeXmlOn()
IntervalChain
-issuer
-serverId
-chainStart
+writeXmlOn()
ArchiveTree
-rootArchive
-branches
+getRootArchive()
+writeXmlOn()
ProofMarkReference
-sequenceNumber
1
0..*

FIG. 15

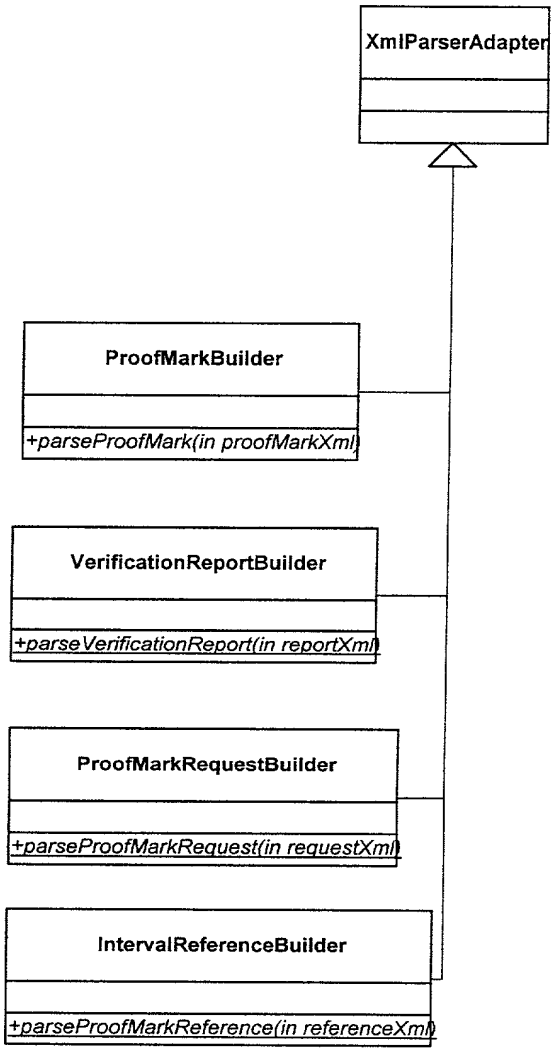

XmlParserAdapter
ProofMarkBuilder
+parseProofMark(in proofMarkXml)
VerificationReportBuilder
+parseVerificationReport(in reportXml)
ProofMarkRequestBuilder
+parseProofMarkRequest(in requestXml)
IntervalReferenceBuilder
+parseProofMarkReference(in referenceXml)

FIG. 16

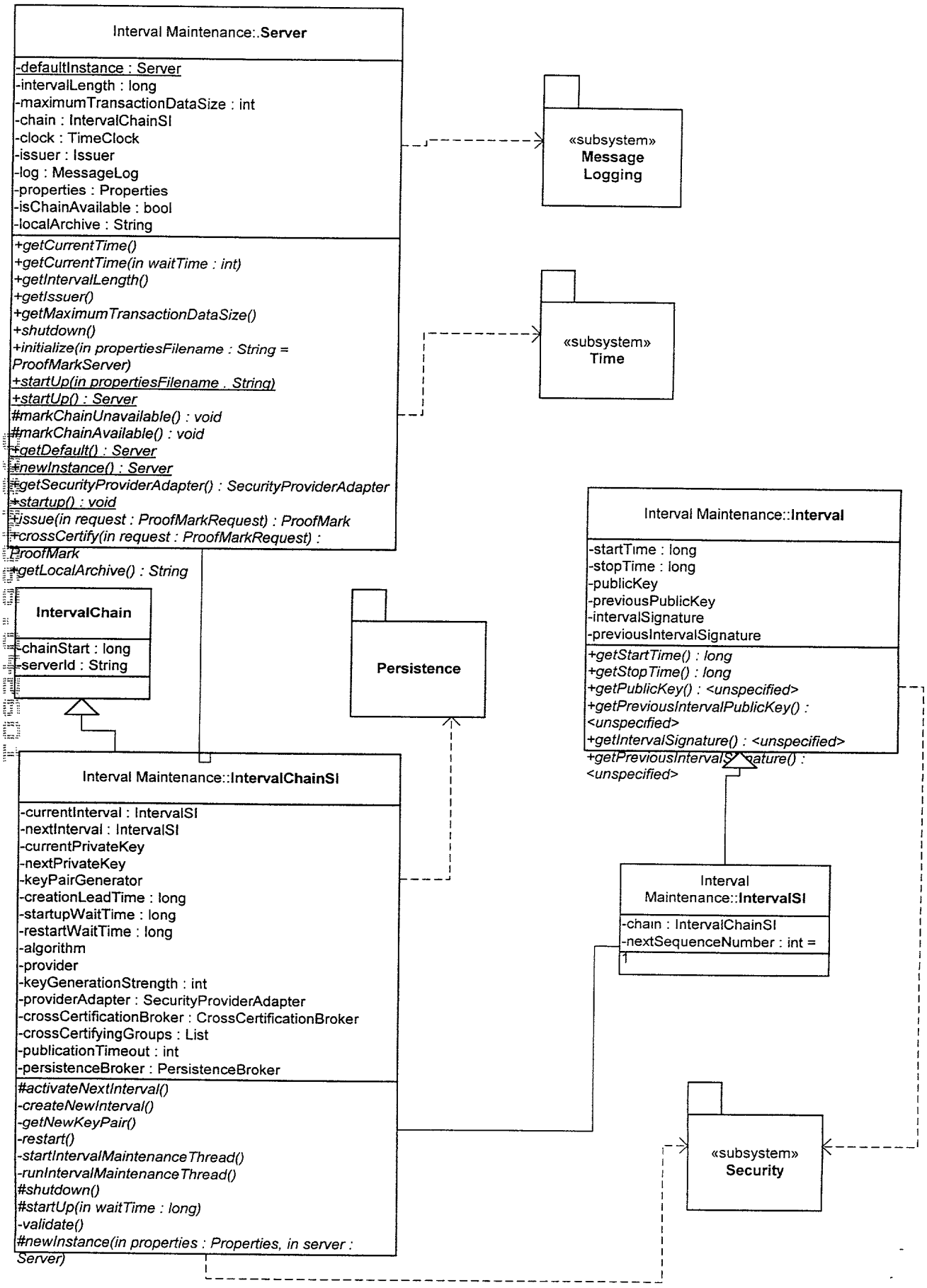

Interval Maintenance::Server
-defaultInstance : Server
-intervalLength : long
-maximumTransactionDataSize : int
-chain : IntervalChainSI
-clock : TimeClock
-issuer : Issuer
-log : MessageLog
-properties : Properties
-isChainAvailable : bool
-localArchive : String
+getCurrentTime()
+getCurrentTime(in waitTime : int)
+getIntervalLength()
+getIssuer()
+getMaximumTransactionDataSize()
+shutdown()
+initialize(in propertiesFilename : String = ProofMarkServer)
+startUp(in propertiesFilename : String)
+startUp() : Server
#markChainUnavailable() : void
#markChainAvailable() : void
+getDefault() : Server
+newInstance() : Server
+getSecurityProviderAdapter() : SecurityProviderAdapter
+startup() : void
+issue(in request : ProofMarkRequest) : ProofMark
+crossCertify(in request : ProofMarkRequest) : ProofMark
+getLocalArchive() : String
«subsystem» Message Logging
«subsystem» Time
IntervalChain
-chainStart : long
-serverId : String
Persistence
Interval Maintenance::Interval
-startTime : long
-stopTime : long
-publicKey
-previousPublicKey
-intervalSignature
-previousIntervalSignature
+getStartTime() : long
+getStopTime() : long
+getPublicKey() : <unspecified>
+getPreviousIntervalPublicKey() : <unspecified>
+getIntervalSignature() : <unspecified>
+getPreviousIntervalSignature() : <unspecified>
Interval Maintenance::IntervalChainSI
-currentInterval : IntervalSI
-nextInterval : IntervalSI
-currentPrivateKey
-nextPrivateKey
-keyPairGenerator
-creationLeadTime : long
-startupWaitTime : long
-restartWaitTime : long
-algorithm
-provider
-keyGenerationStrength : int
-providerAdapter : SecurityProviderAdapter
-crossCertificationBroker : CrossCertificationBroker
-crossCertifyingGroups : List
-publicationTimeout : int
-persistenceBroker : PersistenceBroker
#activateNextInterval()
-createNewInterval()
-getNewKeyPair()
-restart()
-startIntervalMaintenanceThread()
-runIntervalMaintenanceThread()
#shutdown()
#startUp(in waitTime : long)
-validate()
#newInstance(in properties : Properties, in server : Server)
Interval Maintenance::IntervalSI
-chain : IntervalChainSI
-nextSequenceNumber : int = 1
«subsystem» Security

FIG. 17

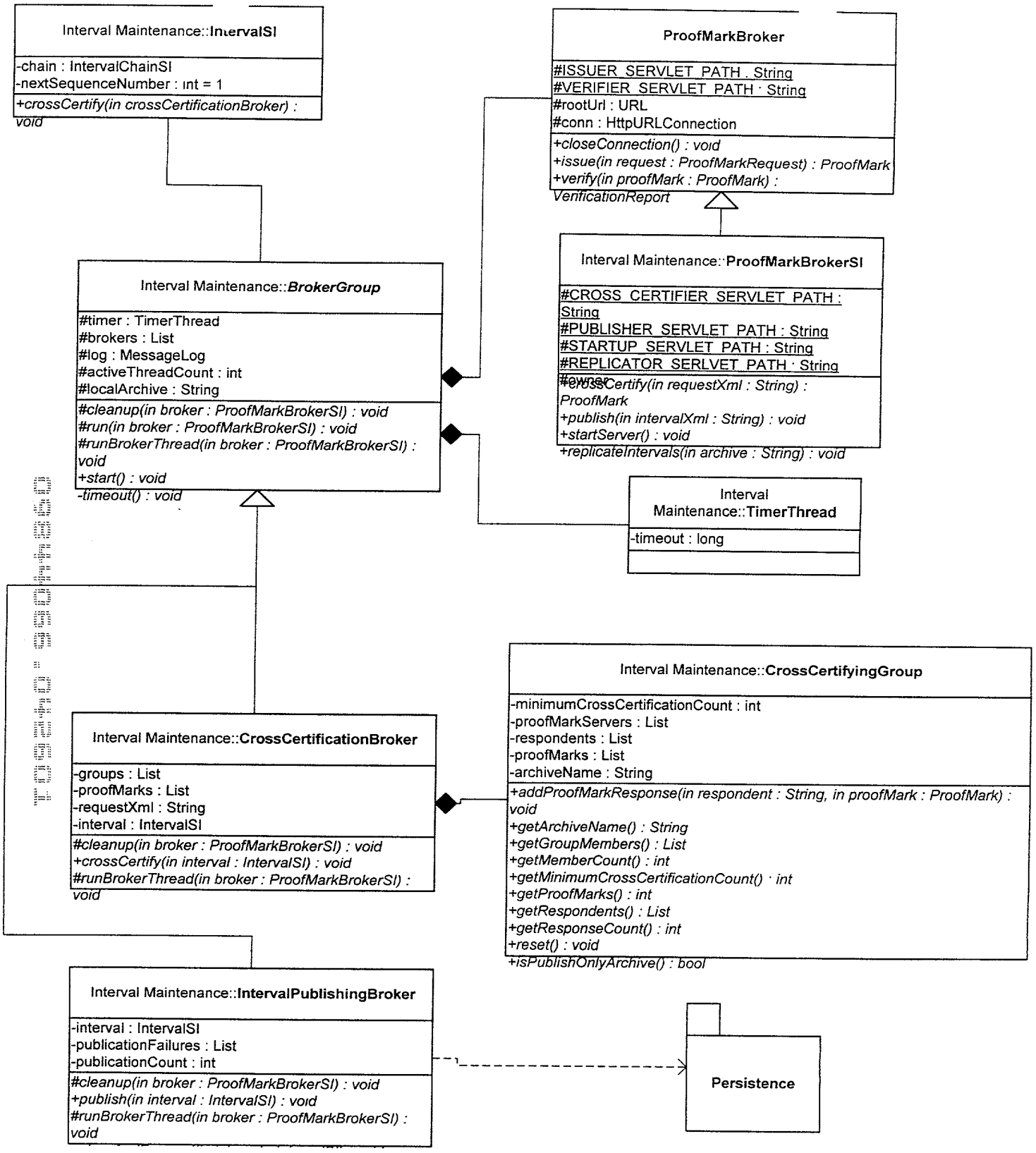

Interval Maintenance::IntervalSI
-chain : IntervalChainSI
-nextSequenceNumber : int = 1
+crossCertify(in crossCertificationBroker) : void
ProofMarkBroker
#ISSUER_SERVLET_PATH : String
#VERIFIER_SERVLET_PATH : String
#rootUrl : URL
#conn : HttpURLConnection
+closeConnection() : void
+issue(in request : ProofMarkRequest) : ProofMark
+verify(in proofMark : ProofMark) : VerificationReport
Interval Maintenance::ProofMarkBrokerSI
#CROSS_CERTIFIER_SERVLET_PATH : String
#PUBLISHER_SERVLET_PATH : String
#STARTUP_SERVLET_PATH : String
#REPLICATOR_SERLVET_PATH : String
#owner
+crossCertify(in requestXml : String) : ProofMark
+publish(in intervalXml : String) : void
+startServer() : void
+replicateIntervals(in archive : String) : void
Interval Maintenance::BrokerGroup
#timer : TimerThread
#brokers : List
#log : MessageLog
#activeThreadCount : int
#localArchive : String
#cleanup(in broker : ProofMarkBrokerSI) : void
#run(in broker : ProofMarkBrokerSI) : void
#runBrokerThread(in broker : ProofMarkBrokerSI) : void
+start() : void
-timeout() : void
Interval Maintenance::TimerThread
-timeout : long
Interval Maintenance::CrossCertifyingGroup
-minimumCrossCertificationCount : int
-proofMarkServers : List
-respondents : List
-proofMarks : List
-archiveName : String
+addProofMarkResponse(in respondent : String, in proofMark : ProofMark) : void
+getArchiveName() : String
+getGroupMembers() : List
+getMemberCount() : int
+getMinimumCrossCertificationCount() : int
+getProofMarks() : int
+getRespondents() : List
+getResponseCount() : int
+reset() : void
+isPublishOnlyArchive() : bool
Interval Maintenance::CrossCertificationBroker
-groups : List
-proofMarks : List
-requestXml : String
-interval : IntervalSI
#cleanup(in broker : ProofMarkBrokerSI) : void
+crossCertify(in interval : IntervalSI) : void
#runBrokerThread(in broker : ProofMarkBrokerSI) : void
Interval Maintenance::IntervalPublishingBroker
-interval : IntervalSI
-publicationFailures : List
-publicationCount : int
#cleanup(in broker : ProofMarkBrokerSI) : void
+publish(in interval : IntervalSI) : void
#runBrokerThread(in broker : ProofMarkBrokerSI) : void
Persistence

FIG. 18

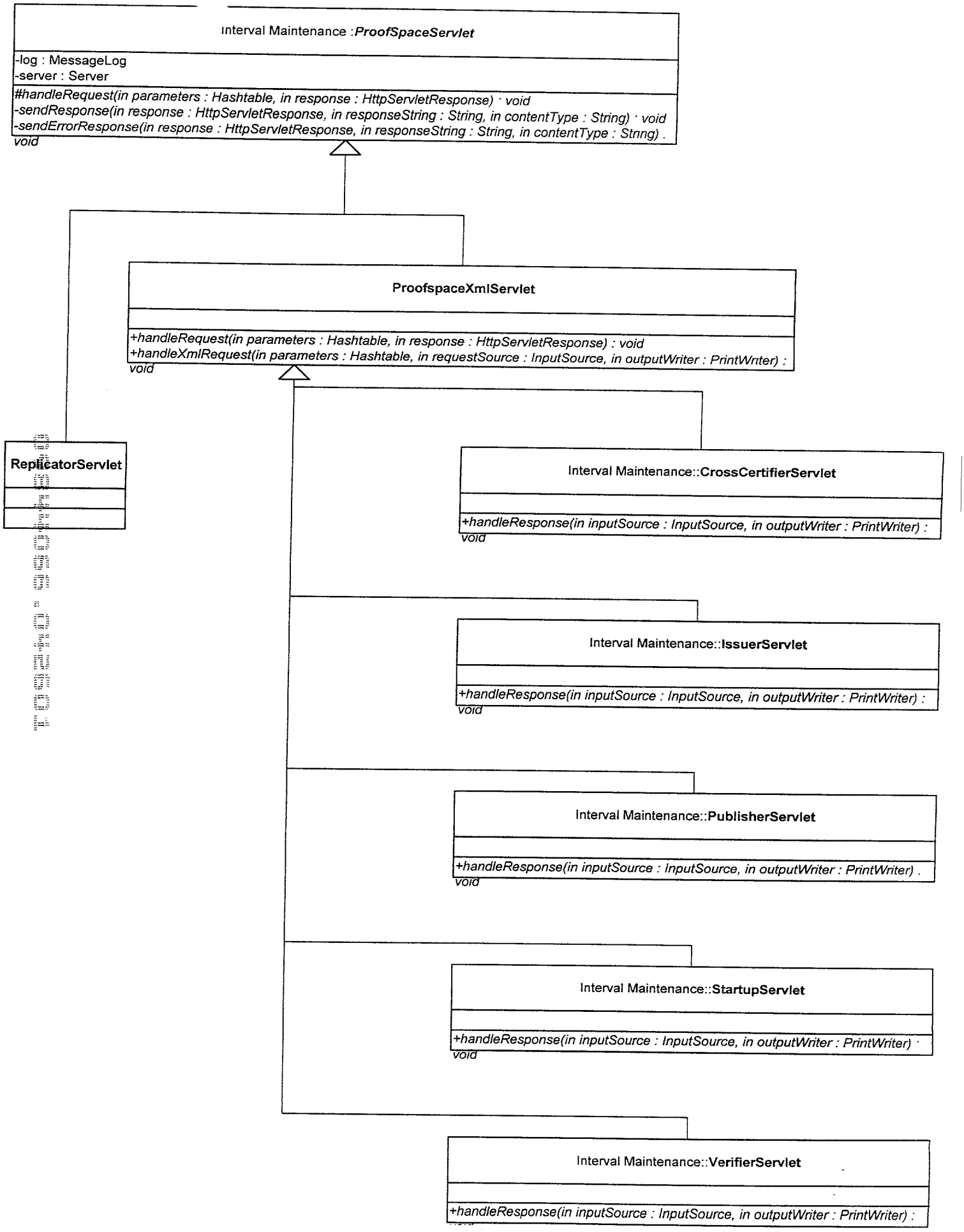

Interval Maintenance :ProofSpaceServlet
-log : MessageLog
-server : Server
#handleRequest(in parameters : Hashtable, in response : HttpServletResponse) · void
-sendResponse(in response : HttpServletResponse, in responseString : String, in contentType : String) · void
-sendErrorResponse(in response : HttpServletResponse, in responseString : String, in contentType : String) .
void
ProofspaceXmlServlet
+handleRequest(in parameters : Hashtable, in response : HttpServletResponse) : void
+handleXmlRequest(in parameters : Hashtable, in requestSource : InputSource, in outputWriter : PrintWriter) :
void
ReplicatorServlet
Interval Maintenance::CrossCertifierServlet
+handleResponse(in inputSource : InputSource, in outputWriter : PrintWriter) :
void
Interval Maintenance::IssuerServlet
+handleResponse(in inputSource : InputSource, in outputWriter : PrintWriter) :
void
Interval Maintenance::PublisherServlet
+handleResponse(in inputSource : InputSource, in outputWriter : PrintWriter) .
void
Interval Maintenance::StartupServlet
+handleResponse(in inputSource : InputSource, in outputWriter : PrintWriter) ·
void
Interval Maintenance::VerifierServlet
+handleResponse(in inputSource : InputSource, in outputWriter : PrintWriter) :

FIG. 19

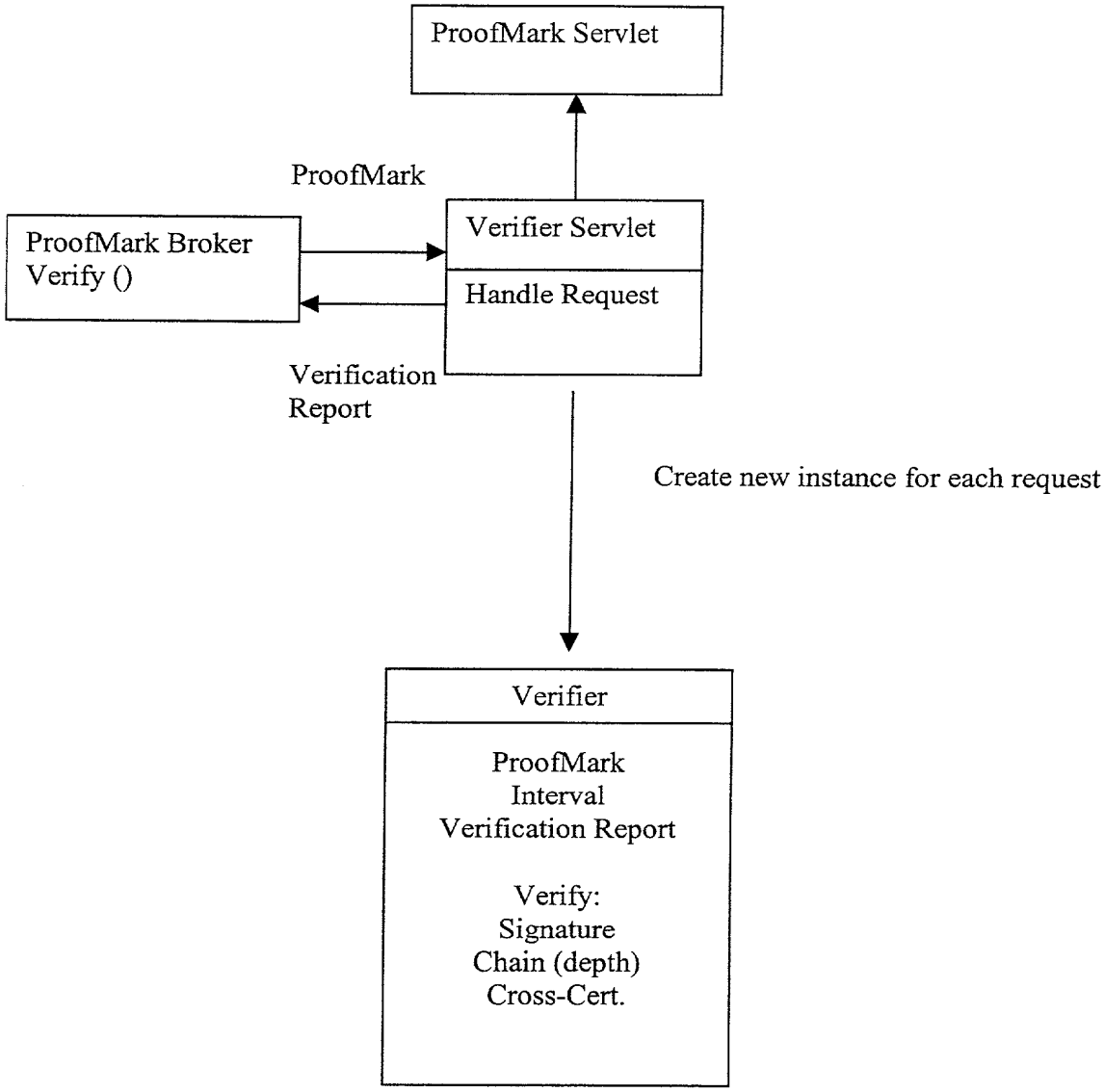

ProofMark Servlet
ProofMark
ProofMark Broker
Verify ()
Verifier Servlet
Handle Request
Verification
Report
Create new instance for each request
Verifier
ProofMark
Interval
Verification Report
Verify:
Signature
Chain (depth)
Cross-Cert.

FIG. 20

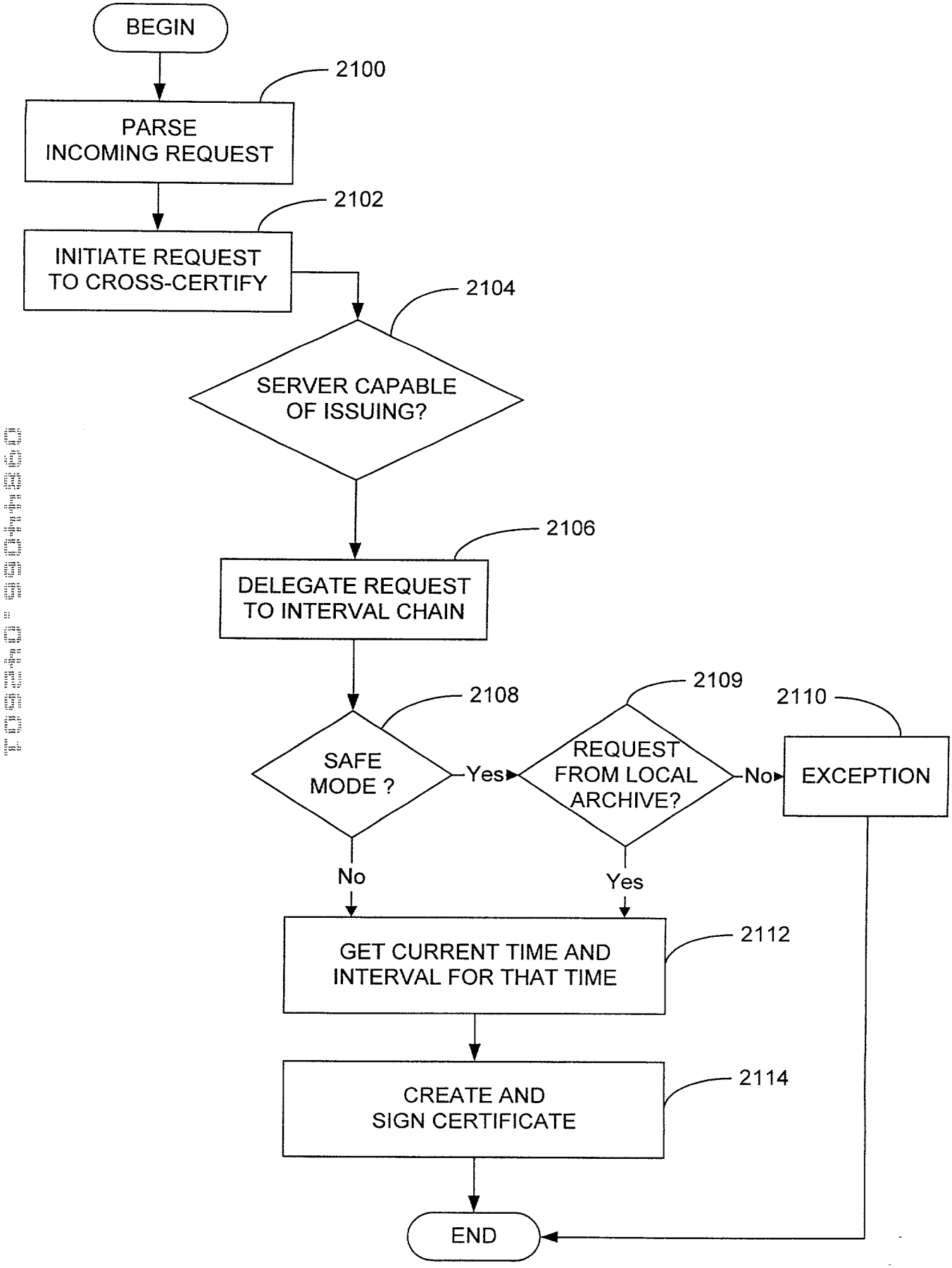

BEGIN
2100
PARSE INCOMING REQUEST
2102
INITIATE REQUEST TO CROSS-CERTIFY
2104
SERVER CAPABLE OF ISSUING?
2106
DELEGATE REQUEST TO INTERVAL CHAIN
2108
SAFE MODE ?
Yes
2109
REQUEST FROM LOCAL ARCHIVE?
No
2110
EXCEPTION
No
Yes
2112
GET CURRENT TIME AND INTERVAL FOR THAT TIME
2114
CREATE AND SIGN CERTIFICATE
END

FIG. 21

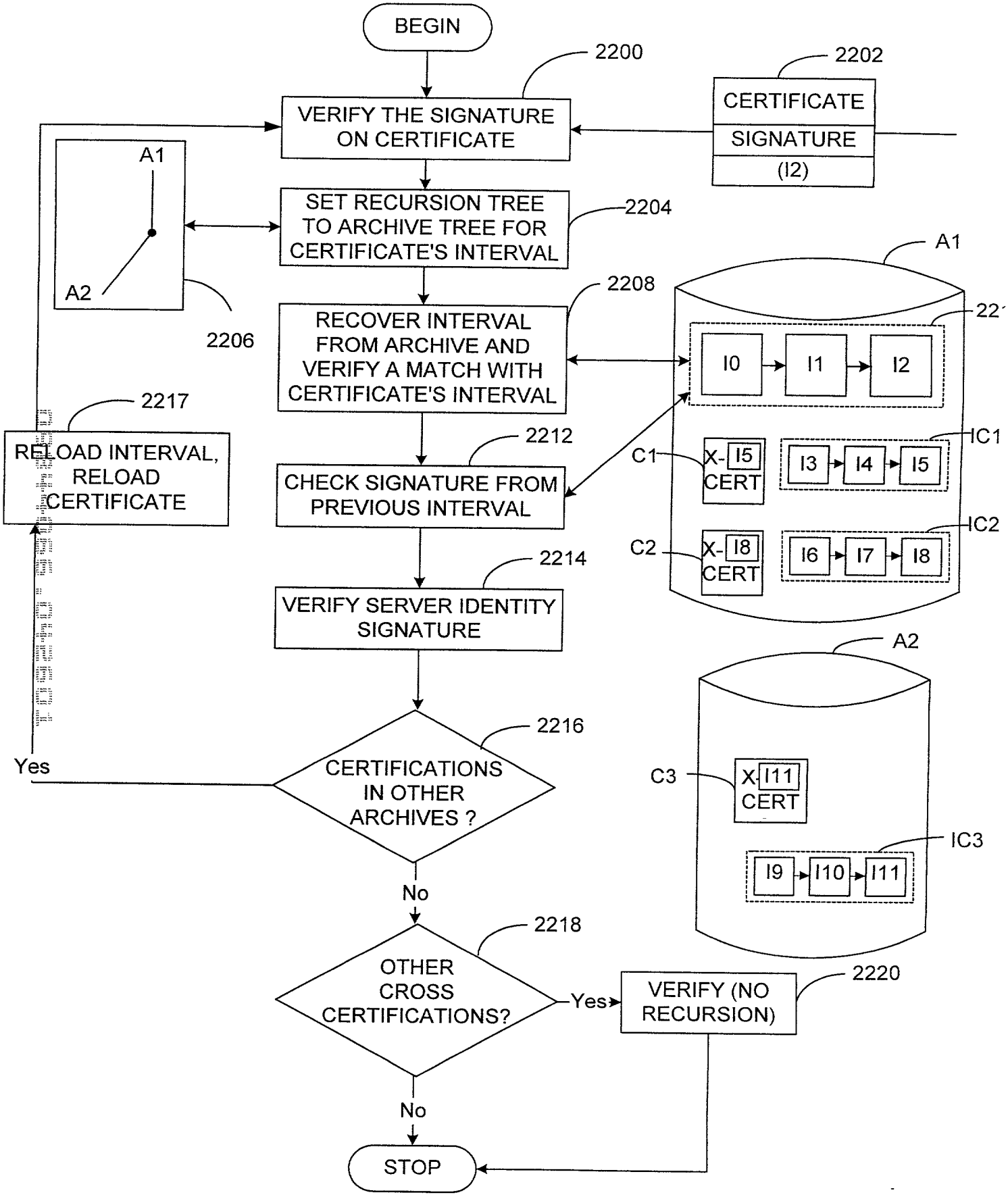

BEGIN
2200
VERIFY THE SIGNATURE ON CERTIFICATE
2202
CERTIFICATE
SIGNATURE
(I2)
A1
A2
2206
SET RECURSION TREE TO ARCHIVE TREE FOR CERTIFICATE'S INTERVAL
2204
RECOVER INTERVAL FROM ARCHIVE AND VERIFY A MATCH WITH CERTIFICATE'S INTERVAL
2208
A1
I0
I1
I2
C1
X-I5 CERT
I3
I4
I5
IC1
C2
X-I8 CERT
I6
I7
I8
IC2
2217
RELOAD INTERVAL, RELOAD CERTIFICATE
2212
CHECK SIGNATURE FROM PREVIOUS INTERVAL
2214
VERIFY SERVER IDENTITY SIGNATURE
A2
C3
X-I11 CERT
I9
I10
I11
IC3
2216
Yes
CERTIFICATIONS IN OTHER ARCHIVES ?
No
2218
OTHER CROSS CERTIFICATIONS?
Yes
VERIFY (NO RECURSION)
2220
No
STOP

FIG. 22